

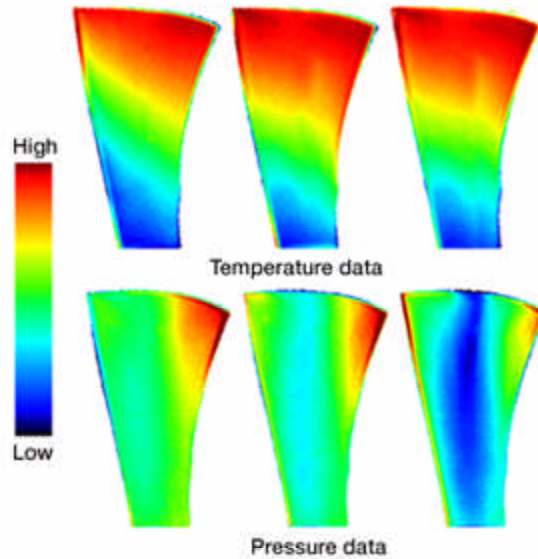
Luminescent Paints Used for Rotating Temperature and Pressure Measurements on Scale-Model High-Bypass-Ratio Fans

NASA Lewis Research Center is a leader in the application of temperature- and pressure-sensitive paints (TSP and PSP) in rotating environments. Tests were recently completed on several scale model, high-bypass-ratio turbofans in Lewis' 9- by 15-Foot Low-Speed Wind Tunnel. Two of the test objectives were to determine the aerodynamic and acoustic performance of the fan designs. Using TSP and PSP, researchers successfully achieved full-field aerodynamic loading profiles. The visualized loading profiles may help researchers identify factors contributing to the fans' performance and to the acoustic characteristics associated with the flow physics on the surface of the blades.



Fan rig mounted in Lewis' 9- by 15-Foot Low-Speed Wind Tunnel. Blades are painted with TSP and PSP.

TSP and PSP were applied to individual blades 180° opposed on the fan rig. The painted blades were illuminated with multiple optically filtered high-speed strobes mounted in the test section wall. A rig-speed signal routed through an electronic shaft encoder controlled the firing of the strobes so that they would always "stop" the motion of the blades in the same location independent of the rig speed. Light emitted from the painted blades was detected with a cooled, digital, scientific-grade CCD (charge couple discharge) camera whose shutter was open for a controlled number of strobed revolutions. Temperature and pressure images were acquired sequentially with the same camera and optic filters.



Sequence of temperature and pressure images for a fan blade at constant speed but with varied aerodynamic loading.

Wind-off reference images and wind-on data images were needed for both TSP and PSP blades. Taking the ratio of the reference and data images enabled corrections for nonuniform illumination and paint application. A general calibration supplied by the paint manufacturer was used for the normalized temperature and pressure images. Then, temperature dependence information from the paint supplier and acquired TSP data were used to correct the PSP images.

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